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REPORT ON WATER QUALITY IN HEAD LAKE

1972

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Ministry
of the
Environment

The Honourable
William G. Newman,
Minister

Everett Biggs,
Deputy Minister

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REPORT ON WATER QUALITY

in

HEAD LAKE

1972

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PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and its surrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an even greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970 in order to solve the cottage waste disposal problem in recreational lakes. There are three on-going studies carried out by the Ministry:

- (1) evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory.
- (2) research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private waste disposal;
- (3) evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Head Lake is one of a series dealing with the water quality aspects of the recreational lakes studied in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

Surveys were carried out in Head Lake in 1972 in May, August and September, to evaluate the present status of the water quality with respect to bacteria, algae and mineral chemistry. Plant nutrient and dissolved oxygen concentrations in the surface and bottom waters were determined.

The lake is located in south-central Ontario in the townships of Laxton and Digby, in the county of Victoria. The lake is rectangular shaped with a surface area of 8.8 square kilometers (3.4 square miles) and a shoreline length of 18.0 kilometers (11.2 miles).

Head Lake had fair bacteriological water quality and was generally within the Ministry of the Environment Recreational use Criteria. However, there were several indications of minor bacterial pollution sources during the three surveys, generally within the areas of the inlets (Head River and the stream from Rush Lake) as well as along the east shore.

While the flow and mineral content of the two main inflows to Head Lake differed markedly, Head Lake and its outflow were remarkably uniform, with a moderate mineral content, no temperature stratification and ample dissolved oxygen at all depths. The low chlorophyll a and nutrient content, combined with reasonably good transparency are characteristic of a lake with a low level of productivity.

PURPOSE OF THE SURVEYS

The surveys were designed, and tests selected, in order to evaluate the present conditions in the lakes with respect to:

- concentration of bacteria
- plant nutrients and algae
- water quality with depth
- inventory of shoreline development

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions since most disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers

(plant nutrients), mainly nitrogen and phosphorus, support extensive growths of rooted aquatic plants and microscopic free-floating plants called algae. Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

Aquatic weed beds provide shelter and food for many kinds of fish. Too much growth is undesirable since it can upset the oxygen balance in the lake and can interfere with recreational uses.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from May 29 to June 2, from August 14 to 18 and from September 13 to 17.

A proper estimation of the bacterial population requires several measurements over a period of time which can then be averaged as a geometric mean. Measurements over five consecutive days at each station are regarded as the minimum number which will give reliable bacterial data.

Chemical samples were collected on the first and last days of the surveys at inlet and outlet stations and at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Thirty-seven bacteriological sample sites were established over the whole lake (Figure 1). Chemical samples were collected at the two inlet stations, the outlet station and three mid-lake stations. In addition to these surface samples, chemical and bacteriological samples were taken from the bottom water at the mid-lake stations.

Field Tests

The variation in temperature and dissolved oxygen values with depth were measured at the three deep water stations with an electronic probe lowered into the lake and water clarity was measured with a Secchi disc, (Figure 2). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal coliforms and fecal streptococci organisms are all indigenous to man and other warm blooded animals and found in the colon

LEGEND

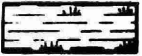
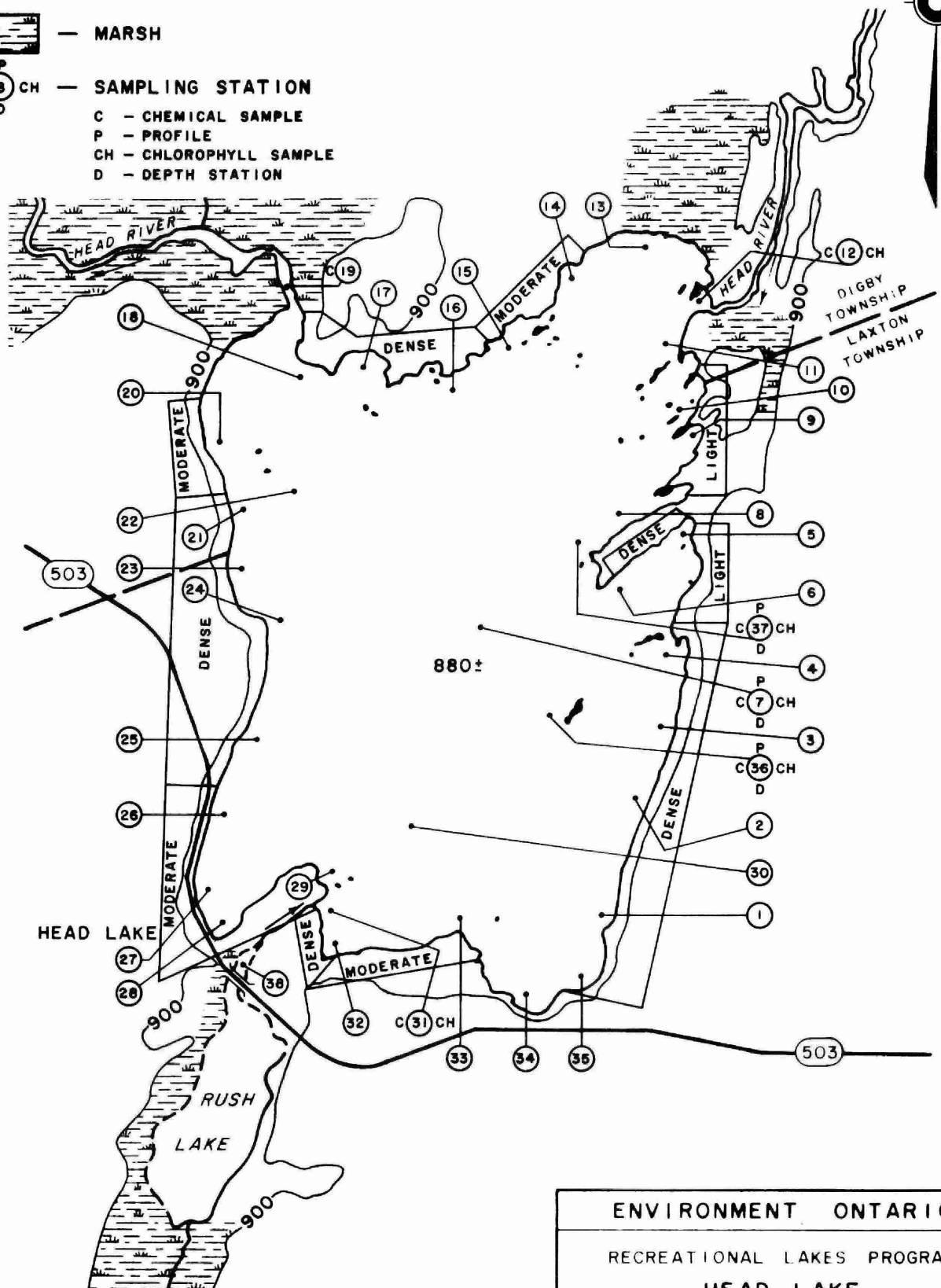
- DENSE — COTTAGE DEVELOPMENT
- 900 — CONTOUR INTERVAL
-  — MARSH
-  — SAMPLING STATION
 - C — CHEMICAL SAMPLE
 - P — PROFILE
 - CH — CHLOROPHYLL SAMPLE
 - D — DEPTH STATION

FIGURE 1 — COTTAGE DEVELOPMENT AND SAMPLING STATIONS OF HEAD LAKE



ENVIRONMENT ONTARIO

RECREATIONAL LAKES PROGRAM

HEAD LAKE

1972 WATER QUALITY SURVEY

SCALE: AS SHOWN

DRAWN BY: A.R.S.

DATE: NOV., 1972

CHECKED BY:

DRAWING NO. 72-74-DE

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Clear, algae-free lake:
Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake:
Secchi disc readings tend to be less than 3m (9 feet).

Secchi Disc Reading

2 times Secchi disc reading

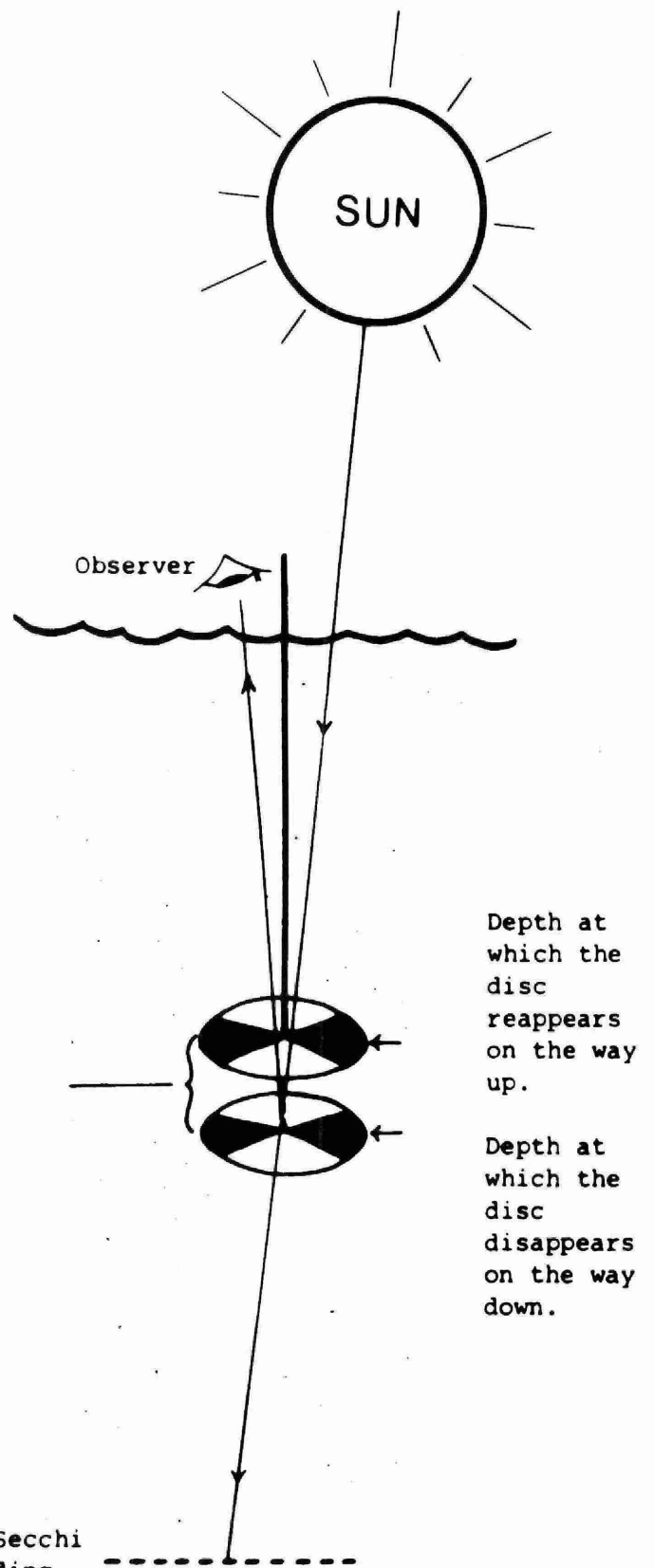


FIGURE 2: USE OF SECCHI DISC TO DETERMINE WATER CLARITY

and feces in tremendous numbers. These indicator organisms in the water denote the presence of fecal contamination and hence the risk of disease causing organisms.

Standard plate count (SPC) determinations were made on some mid-lake stations in order to determine densities of some natural water bacteria. The SPC media will only support the growth of those organisms that don't require special nutrients, oxygen requirements and/or incubation temperatures. The SPC is used as a measure of general bacterial activity.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques depend on the mineral content.

Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the midlake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total Kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the inlet and bottom water samples. They are particularly important in bottom waters, since nitrogen may be regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of algae in the water. The live algae are confined mainly to the lighted surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by raising the sample bottle through the depth of this illuminated zone as it filled. The sample was then representative of the average number of algae through the illuminated depth of the surface waters.

DESCRIPTION OF HEAD LAKE AREA

Lake and Soil Characteristics

Head Lake is located in south-central Ontario in the townships of Laxton and Digby in Victoria County approximately 30 miles north-west of Lindsay.

The area surrounding the lake is generally comprised of moderately undulating hills. The shoreline is made up of two types of soil; Dummer Loam Shallow Phase and Rockland. The shallow phase loam has a thin cover of stony glacial till over the limestone bedrock. Rockland is composed of 10 - 25% Wendigo Sand with the remainder being shallow sand with frequent outcroppings of bedrock. The west and north shores of the lake are Rockland while the south and east shores are the shallow phase loam.

The 18.0 kilometer (11.2 mile) shoreline is dominated by steep slopes on the west and east sides of the lake with shallow soil cover whereas the north and south ends of the lake have lesser slopes with greater soil cover. In most cases the terrain back of the shoreline consists of mixed bush on the east and north sides, while along the south shore and one-half way up to the west side the bush is thinner. In the north-east sector, swamp land dominates the shoreline along Head River.

The shape of the lake is rectangular in appearance, approximately 3.2 kilometers (2 miles) long by 2.4 kilometers (1½ miles) wide, with the long axis in a north-south position. The lake has a water surface area of 8.8 square kilometers (3.4 square miles), a shoreline length of 18.0 kilometers (11.2 miles) and is shallow, with a maximum depth of 6.5 m (21 feet) and a mean depth of 3.5 m (11.4 feet).

Head Lake, at an elevation of 267.5 meters (880 feet) above sea level, drains an approximate area of 51.3 square kilometers (14.3 square miles). The largest flow enters via the Head River (which drains Fishog Lake) at the north-east sector of Head Lake and the other inflow enters from the south-west corner. Head Lake drains via the Head River in the north-west sector, ending in the Severn River.

Shoreline Development

At the present time there are approximately 225 cottages and 2 resorts on the lake. One marina is situated on the east side of the lake at the end of a small bay (Figure 1).

The lower east side, and middle half of the west side of the lake is fully developed as well as the northern shore extending from the outlet of the Head River to the marsh at the north-east sector. At the southern end of the lake there is a small park with picnic tables, 2 outhouses, and a beach with facilities for launching small water craft.

Development is scarce along the upper quarter on the west side as well on the north-east corner due to marshy conditions.

Water Usage

Head Lake is used for recreational purposes such as boating, swimming and angling. Most of the cottages also use the lake as their source of domestic water supply.

There is a great variety of fish in the lake with maskinonge, small mouth and largemouth bass being the prevalent game fish. Some common and coarse fish found in Head Lake are white sucker, brown bullhead, pumpkinseed and yellow perch.

RESULTS AND DISCUSSION

Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the analysis of variance and Barlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas, or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

During the spring and the fall surveys, Head Lake was, with a few exceptions, well within the Ministry of the Environment Microbiological Criteria for Total Body Contact Recreation, which states: "Where ingestion is probable, recreational waters can be considered impaired when the coliform (TC), fecal coliform (FC), and/or enterococcus (FS) geometric mean density exceeds 1000, 100 and/or 20 per 100 ml respectively. However, in the summer survey most of the lake exceeded the TC criteria.

During the May survey, most of the lake (Group A) was homogeneous with overall geometric mean bacterial levels of 46 TC, 2FC and 3FS/100 ml (Figure 3). Higher bacterial densities were detected at the mouth of the Rush River (Station 31) which had 104TC, 23FC and 36FS/100 ml.; the mouth of the Head River (Station 12) which had 360TC and 8FC/100 ml and Station

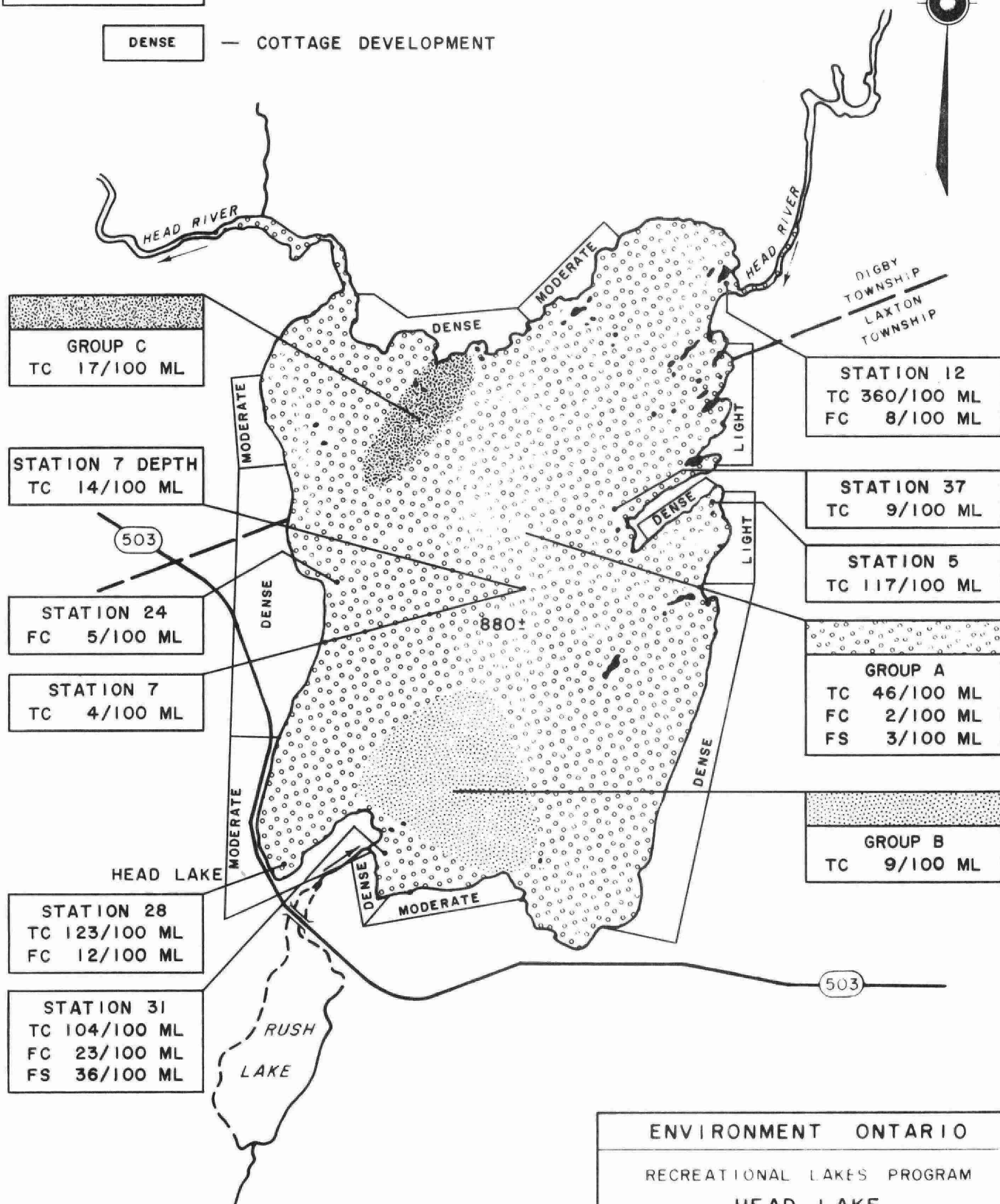
LEGEND

GROUP OR STATION
TC GM/100 ML
FC GM/100 ML
FS GM/100 ML

DENSE

— COTTAGE DEVELOPMENT

FIGURE 3 - DISTRIBUTION OF BACTERIA IN MAY



0 1/4 1/2 3/4 1 MILES

ENVIRONMENT ONTARIO

RECREATIONAL LAKES PROGRAM

HEAD LAKE

1972 WATER QUALITY SURVEY

SCALE AS SHOWN

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28 in the south-west bay which had 123TC and 12FC/100 ml. All these stations appeared to be affected by minor bacterial inputs.

Station 5, on the eastern shore had slightly higher TC levels than Group A with 117TC/100 ml while the mid-lake stations 37, 7 and 7D had lower TC levels of 9, 4 and 14 respectively. Similarly, Group B off the south shore and Group C near the north-east shore had low TC means of 9 and 17 respectively.

In the August survey, most of the lake (Group A) was homogeneous with geometric mean bacterial levels of 1,481TC, 2FC and 4FS/100 ml (Figure 4). The TC levels exceeded the MOE Criteria, however, the relatively low FC and FS levels do not confirm that a substantial health risk existed for recreational use in the Group A area.

Even higher TC levels were encountered in other areas of Head Lake: Group B, which includes the outflow of the Head River and south along the western shore had 4,736TC/100 ml, Station 25, along the heavily developed western shore had 3,473TC/100 ml while Station 27 just south of Station 25 revealed 5,364TC/100 ml. TC levels lower than those in most of the lake were encountered at the mouth of the inflowing Head River (689TC/100 ml) and mid-lake depth Station 7D (495TC/100 ml).

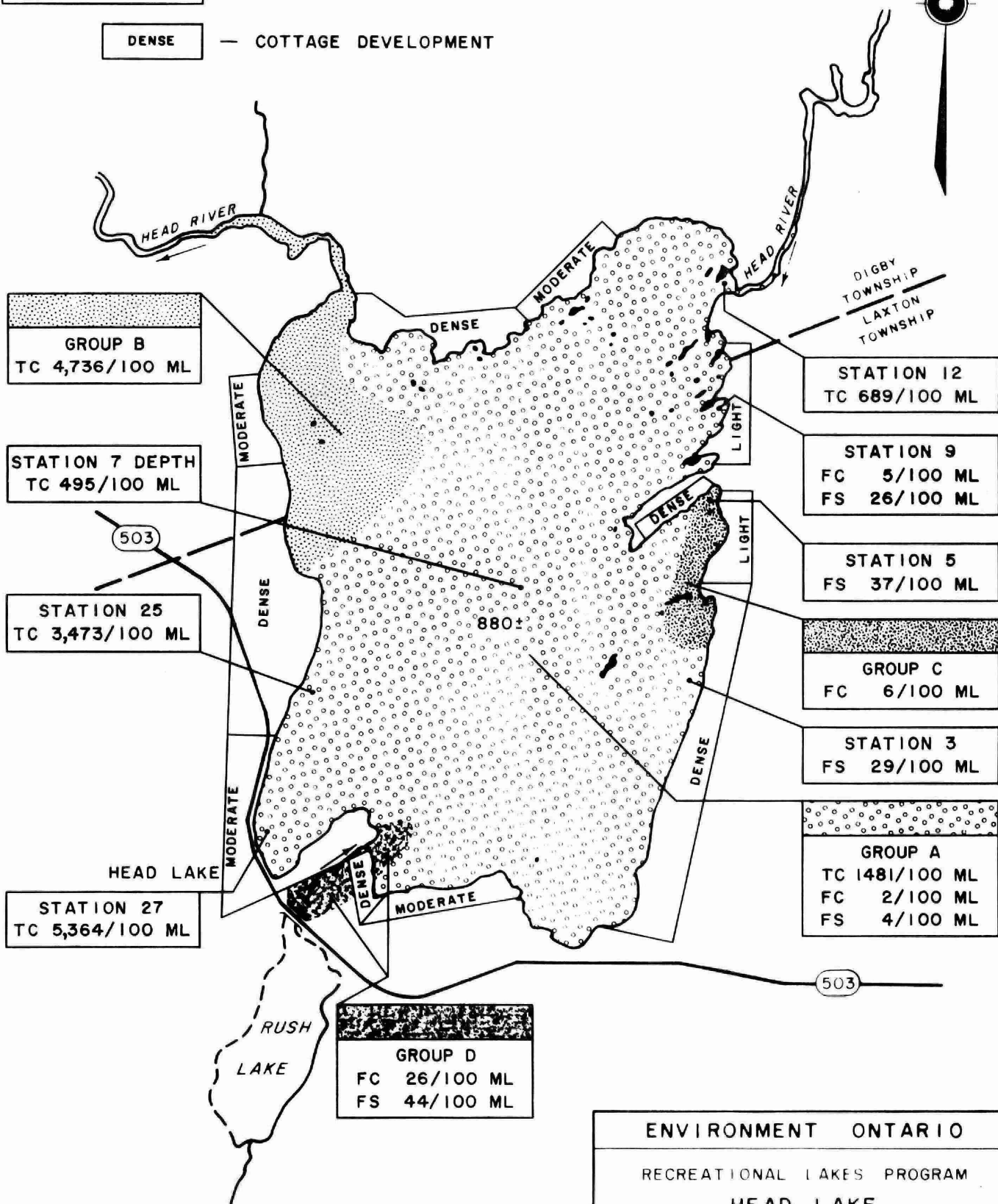
The South inlet from Rush Lake (Group D) again revealed a contamination input with 26FC and 44FS/100 ml. Other areas of high FC levels were detected along the eastern shore at Station 9 and Group C with 5 and 6 FC/100 ml respectively. High FS levels were found in the same areas at Stations 9, 5 and 3 which had respective means of 26, 37 and 29 FS/100 ml, all of which exceeded the MOE recreational use criteria.

LEGEND

GROUP OR STATION
TC GM/100 ML
FC GM/100 ML
FS GM/100 ML

DENSE — COTTAGE DEVELOPMENT

FIGURE 4 - DISTRIBUTION OF BACTERIA IN AUGUST



0 1/4 1/2 3/4 1 MILES

ENVIRONMENT ONTARIO

RECREATIONAL LAKES PROGRAM

HEAD LAKE

1972 WATER QUALITY SURVEY

SCALE AS SHOWN

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In the September survey, most of the lake (Group A) was homogeneous with geometric mean bacterial levels of 90TC, 2FC and 2FS/100 ml (Figure 5). The exceptions were: Station 18 on the north-western shore (9FC/100 ml), Station 9 on the eastern shore (12FC and 11FS/100 ml) and Station 35 on the heavily developed south-east shore (8FC and 9FS).

No major sources of bacterial contamination were detected during the study. However there were scattered localized areas affected by contamination which raised mean bacterial densities above the acceptable level for more than one of the criteria, rendering these areas unsuitable for recreational use involving intimate or prolonged body contact with the water. This is particularly the case with Stations 31 and 9 which had repetitive unacceptably high means.

The sources of this bacterial contamination should be identified and corrected in order that swimming and other body contact recreational use may be made of the entire lake, at any time, without risk to the health of the user.

The Private Waste and Water Management Branch will conduct a survey of waste disposal systems on the shores of Head Lake in order to locate any faulty waste disposal practises and facilities and have them corrected.

Chlorophyll a and Secchi Disc Correlation

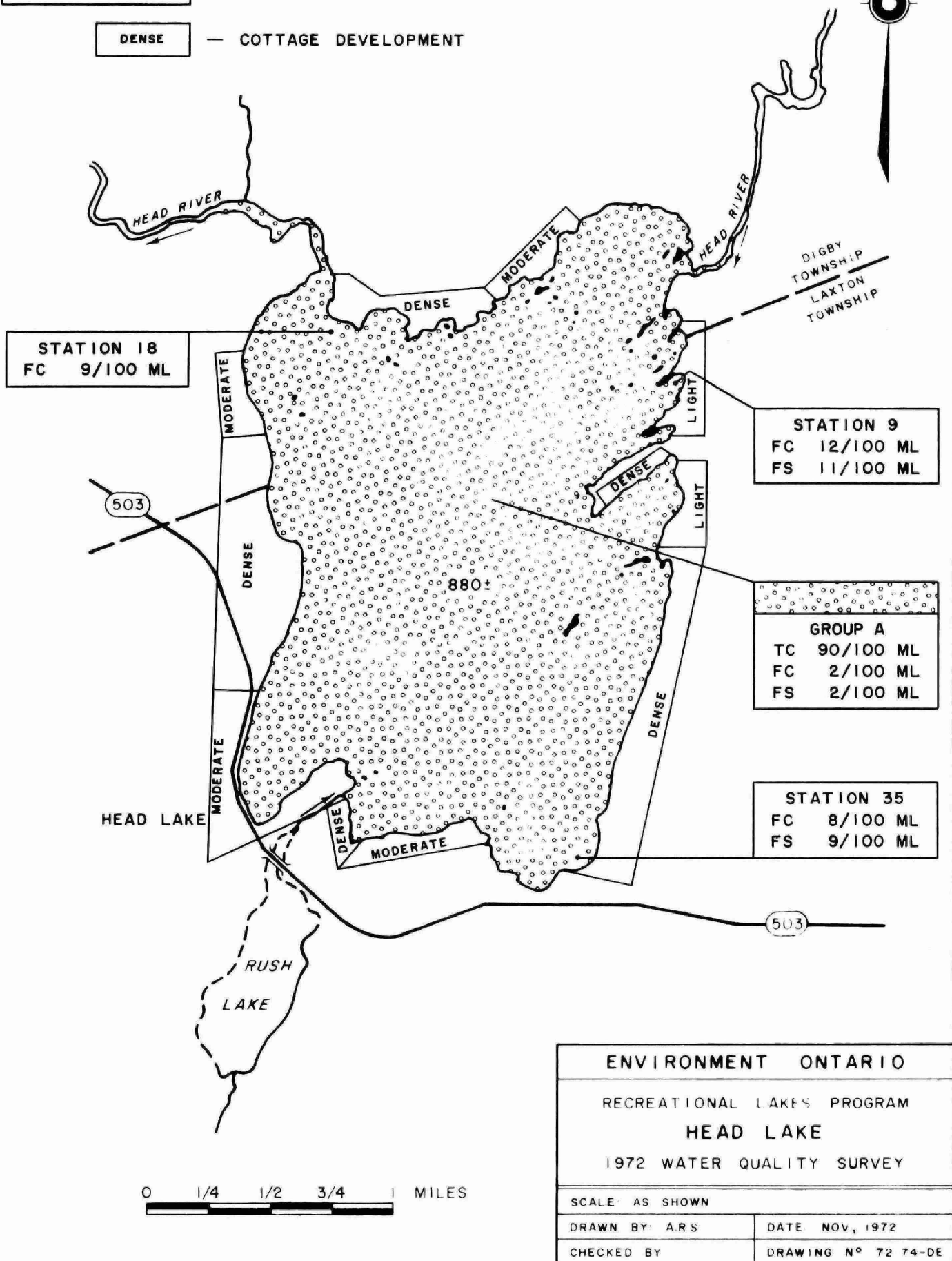
Chlorophyll a levels throughout the lake, while remaining at very low levels, rose slightly from an average of 2.1 ug/l in late May to an average

LEGEND

GROUP OR STATION
 TC GM/100 ML
 FC GM/100 ML
 FS GM/100 ML

DENSE — COTTAGE DEVELOPMENT

FIGURE 5 - DISTRIBUTION OF BACTERIA IN SEPTEMBER



of 2.9 in mid September. Corresponding Secchi Disc readings decreased from an average of 3.7 meters in May to a level of 2.6 in September. In combination with the low plant nutrient concentrations, particularly of phosphorus, these values are characteristic of a lake with a low level of productivity.

On a scale of lake enrichment as indicated by average chlorophyll a concentrations and water transparency (Figure 6), Head Lake is similar to Balsam and Cameron Lakes, two relatively clear water lakes and is far removed from such highly enriched waters as the Western Basin of Lake Erie, Lake Scugog and the Bay of Quinte.

Chemistry

The mineral chemistry of the body of Head Lake was a well-mixed blend of the widely dissimilar mineral contents of the two inflowing streams, as shown in the table below. Head River, the main incoming flow, was of a very low and stable mineral content, whereas the much lower flow from Rush Lake was of high but variable mineral content, reaching maximum levels five or more times those of the Head River.

In view of the wide differences between these inputs, and compared to other recreational lakes studied, the chemistry of Head Lake and its outflow is remarkably uniform.

The mineral content is moderate and the nutrient content is low throughout the length, breadth and depth of the lake. Profiles of temperature and dissolved oxygen content related to depth were uniformly free of any evidence of stratification during each of the three surveys, as would be expected of a shallow lake.

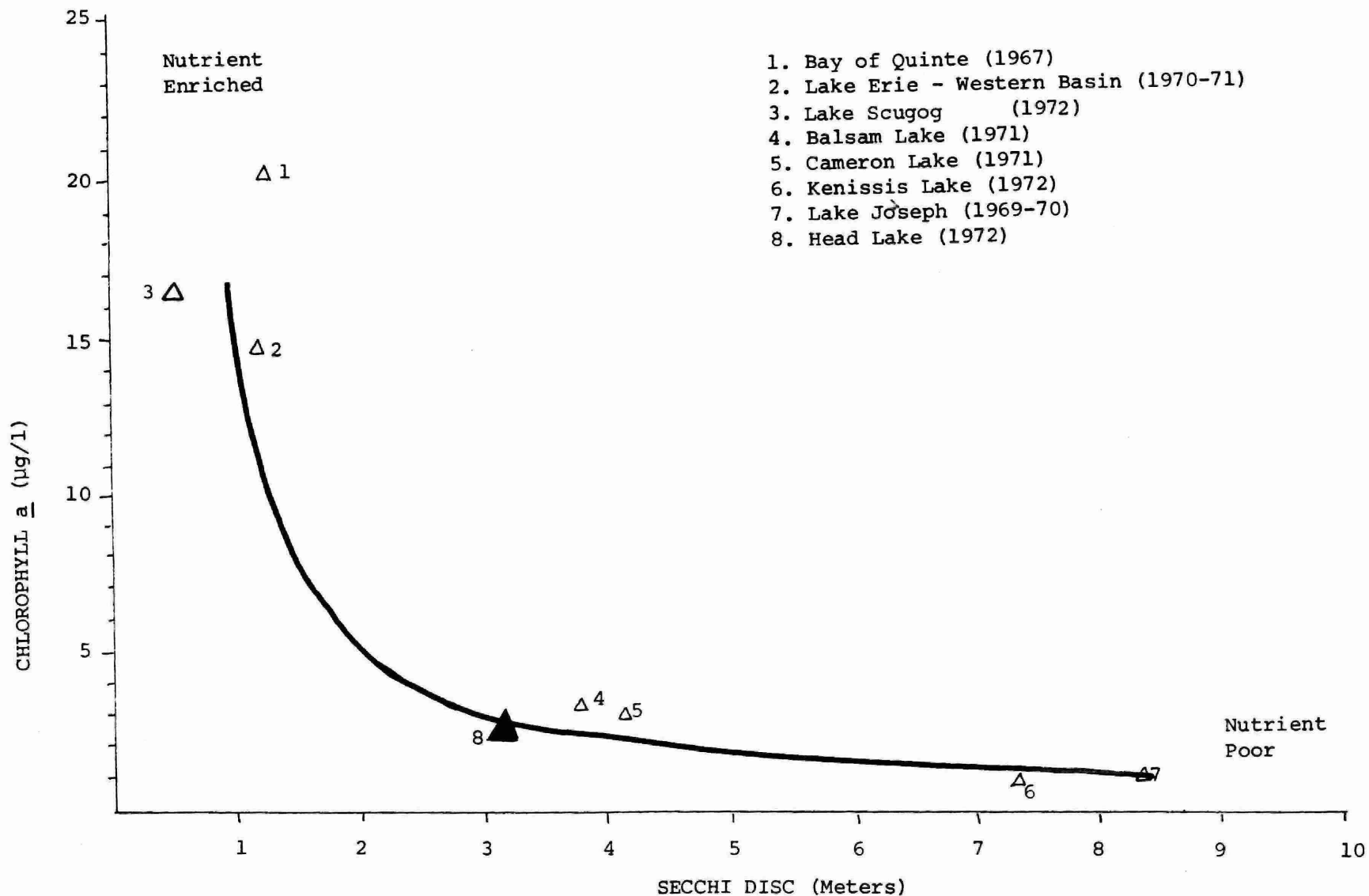


Figure 6 : The mean of chlorophyll a and Secchi disc measurements in Head Lake relative to a curve describing the chlorophyll a - Secchi disc relationship in many Ontario lakes. Seven other well known lakes are included for comparison with Head Lake.

Dissolved oxygen concentrations were close to saturation at all depths .

If Head Lake is kept free of additional inputs of nutrient or organic matter , it is likely that the present acceptable chemical quality will be maintained indefinitely .

	Inflow from Upper Head River	Inflow from Rush Lake	Body of Head Lake, and Outflow to Lower Head River
		<u>May to September</u>	
Conductivity Range, umhos/cms	56 - 60	164 - 300	135 - 161
Hardness Range, as CaCO ₃ , mg/l	28 - 34	86 - 162	72 - 86
Alkalinity Range, as CaCO ₃ , mg/l	20 - 23	72 - 147	63 - 76
Chloride Range, as Cl, mg/l	1 - 3	3 - 7	2 - 4
Total Phosphorus Range, as P, ug/l	18 - 19	11 - 24	11 - 31
Total Kjeldahl Range, as N, ug/l	350 - 480	460 - 650	270 - 680
		<u>May 29 - June 2</u>	
Temperature Range Degrees Centigrade	20.8	22.0	16.0 - 22.0
Dissolved Oxygen Range, mg/l	7.6	9.5	8.5 - 11.6
		<u>August 14 - 18</u>	
Temperature Range, Degrees Centigrade	-	-	19.7 - 20.0
Dissolved Oxygen Range, mg/l	-	-	8.4 - 11.5
		<u>September 13 - 17</u>	
Temperature Range, Degrees Centigrade	-	-	20.1 - 21.8
Dissolved Oxygen Range, mg/l	-	-	9.8 - 10.9

INFORMATION OF GENERAL INTEREST TO COTTAGERS MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria does not change the appearance of the water but pose an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis, but he may catch less infections of gastroenteritis (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These viral infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic

matter in the lake will be used as food by these organisms and will give rise, in turn to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amounts of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems, can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling

Boil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5.1/4% Available Chlorine

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming

strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH
per 10 ft depth of water

Diameter of Well Casing In Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

- 50 feet to any well, lake, stream or pond.
- 5 feet to any building.
- 10 feet to any property boundary

The tile field should not be closer than:

- 100 feet to the nearest dug well.
- 50 feet to a drilled well which has a casing to 25 feet below ground.
- 25 feet to a building
- 10 feet to a property boundary.
- 50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct

connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,

5. in the case of storage devices, be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1.1/2 inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. Fuel hoses must be in good condition and all connections tight.
4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.
5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".
7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscriminate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become

injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters

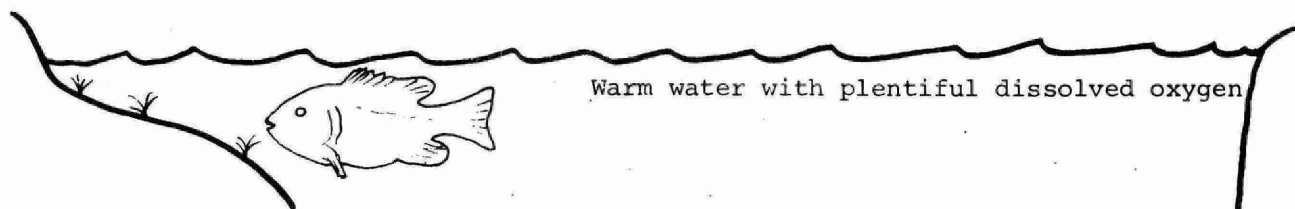
warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page) .

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

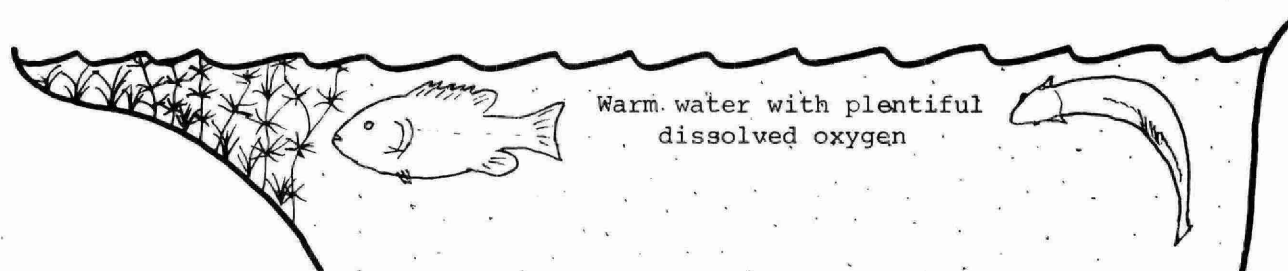
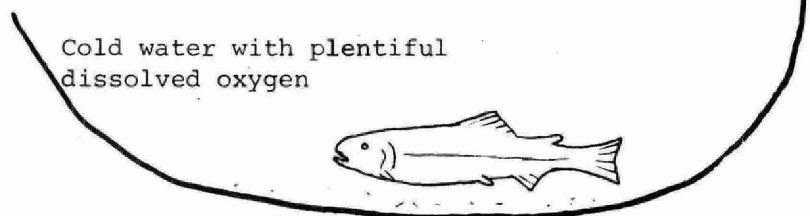
Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with



Surface water and shallows are normally inhabited by warm-water fish such as bass, pike and sunfish.

Bottom waters containing plentiful dissolved oxygen are normally inhabited by cold water species such as lake trout and whitefish.



When excessive nutrients entering a lake result in heavy growths of algae and weeds, the bottom waters are often depleted of dissolved oxygen when these plants decompose. Cold-water species of fish are forced to enter the warm surface waters to obtain oxygen where the high temperatures may be fatal.

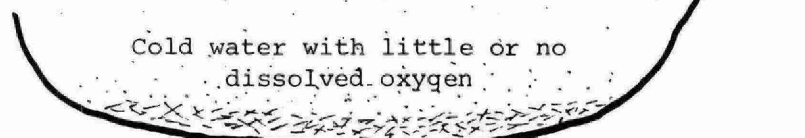


FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced

the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater treatment plants by December 31, 1973, in the most critically affected areas

of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extremely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved

larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.



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